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(54) **HIGH-FREQUENCY PART AND COMMUNICATION DEVICE**

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a small high-frequency device used in apparatuses for conducting wireless communications between electronic or electric equipments.

BACKGROUND OF THE INVENTION

[0002] Data communications by wireless LAN such as IEEE802.11 are now widely used. Wireless data communications are conducted, for instance, in personal computers (PCs), PC peripherals such as printers, hard disk drives and broadband rooters, electronic apparatuses such as facsimiles, refrigerators, standard-definition televisions (SDTVs), high-definition televisions (HDTVs), digital cameras, digital video cameras and mobile phones, signal-transmitting means in automobiles and aircrafts, etc. In addition to single-band communications, multiband communications have been finding wider applications.

[0003] A high-frequency circuit for multiband communications apparatuses using wireless LAN comprises one antenna capable of conducting transmission and reception in two communications systems (IEEE802.11a and IEEE802.11b, and/or IEEE802.11g) having different communications frequency bands, and a high-frequency switch for switching the connection of a transmission circuit and a reception circuit. With wireless apparatuses becoming smaller with higher functions, high-frequency devices have come to have more integrated functions.

[0004] WO 2006/003959 discloses a high-frequency device comprising a high-frequency circuit commonly usable for two communications systems, which comprises switch circuits, power amplifier circuits, etc. This high-frequency device is miniaturized by mounting high-frequency-signal-treating circuits such as switch circuits, power amplifier circuits, etc. on a laminate substrate, but it has been found that higher integration makes electrode patterns closer to each other in the laminate substrate, causing interference. For instance, because electrode patterns connected to transmission ports, reception ports, power supply ports, etc. on the rear surface are formed on pluralities of layers, their interference are likely to occur by miniaturization. Particularly when the number of high-frequency-signal-treating circuits such as switch circuits increases, many power supply lines for their control, etc. exist between signal lines, causing much interference.

[0005] WO 2006/112306 discloses a multiband high-frequency circuit comprising a switch SPDT1 for switching the connections of a multiband antenna to transmit/receive circuits.

[0006] US2001035799 discloses an antenna switch module connected to a common antenna for switching the connection of the antenna to a transmission circuit or a receiving circuit in plural transmitting/receiving systems.

[0007] US2001035799 discloses a circuit board device suppressing with a small number of terminal elements unwanted irradiation originating between a power supply layer and a ground layer, even when a configuration of the power supply layer and the ground layer on the circuit board is complex.

[0008] US6104258 discloses a system for stabilizing the electrical impedance of an electrical interconnecting apparatus including a pair of parallel planar conductors separated by a dielectric layer.

OBJECT OF THE INVENTION

[0009] Accordingly, an object of the present invention is to provide a high-frequency device capable of being miniaturized while effectively preventing interference between power supply lines and signal lines, and a communications apparatus comprising such high-frequency device.

DISCLOSURE OF THE INVENTION

[0010] The high-frequency device of the present invention comprises high-frequency-signal-treating circuits in and on a laminate substrate comprising pluralities of dielectric layers having conductor patterns,

the high-frequency-signal-treating circuits having amplifier circuits and switch circuits,

terminals including input and output terminals of high-frequency signals, the power supply terminals of the amplifier circuits and the power supply terminals of the switch circuits being formed on one main surface of the laminate substrate,

power supply lines each having one end connected each of the power supply terminals of the amplifier circuits and power supply lines each having one end connected to the power supply terminals of the switch circuits being formed on one dielectric layer to constitute a power supply line layer,

a first ground electrode being arranged on the side of the main surface with respect to the power supply line layer, the first ground electrode overlapping at least part of the power supply lines in a lamination direction,

a second ground electrode being arranged on the opposite side of the first ground electrode with respect to the power supply line layer, the second ground electrode overlapping at least part of the power supply lines in a lamination direction, and

the high-frequency-signal-treating circuits being arranged on the opposite side of the power supply line layer with respect to the second ground electrode.

[0011] With the power supply lines sandwiched by a pair of ground electrodes and extending on the power supply line layer with distance from the high-frequency-signal-treating circuits via one of the ground electrodes, interference between the power supply lines and signal

lines for the high-frequency-signal-treating circuits can be prevented, thereby achieving the miniaturization of the high-frequency device without deteriorating high-frequency characteristics.

[0012] Signal lines connected to the input and output terminals of high-frequency signals are preferably not formed on the power supply line layer. Without signal lines on the power supply line layer, interference between the signal lines and the power supply lines can be surely suppressed.

[0013] The terminals are preferably arranged along the edges of the main surface, with the first ground electrode inside the terminals on the main surface. This structure enables the formation of the terminals and the first ground electrode on the same surface, making another dielectric layer for the first ground electrode unnecessary, resulting in a low-height high-frequency device.

[0014] Even when the total number of power supply lines each having one end connected to each of the power supply terminals of the amplifier circuits and power supply lines each having one end connected to each of the power supply terminals of the switch circuits is three or more on the power supply line layer, interference can be prevented sufficiently between power supply lines and signal lines. Having a high degree of freedom in arranging power supply lines on the power supply line layer, the structure of the present invention is suitable particularly when there are a large number of power supply lines.

[0015] At least part of the power supply terminals preferably overlap the second ground electrode in a lamination direction. This structure can prevent interference between the high-frequency-signal-treating circuits and the power supply terminals.

[0016] The other ends of the power supply lines preferably are connected to the high-frequency-signal-treating circuits through via-electrodes formed in a region overlapping the first ground electrode in a lamination direction. This structure can prevent interference with the input and output terminals of high-frequency signals. Regardless of the positions of the power supply terminals, the connecting position of the power supply lines and the high-frequency-signal-treating circuits can be arranged freely on the power supply line layer, resulting in an improved degree of freedom in the arrangement of the power supply lines.

[0017] At least part of the power supply terminals preferably are adjacent to each other. With this structure, the power supply terminals can be gathered, preventing interference between the high-frequency signal terminals and the power supply terminals. When the high-frequency device has a rectangular main surface, the power supply terminals preferably are arranged on the opposing edges of the main surface.

[0018] It is preferable that the dielectric layer is rectangular, and that pluralities of power supply lines extend in two or more of triangular regions obtained by diagonally quartering the power supply line layer. This structure enables long power supply lines to extend on the power supply line layer in conformity with the arrangement of the switch circuits and the amplifier circuits, resulting in the miniaturization of the high-frequency device.

[0019] Grounded via-electrodes preferably are arranged between power supply lines each having one end connected to each of the power supply terminals of the amplifier circuits and power supply lines each having one end connected to each of the power supply terminals of the switch circuits. This structure can suppress interference among the power supply lines.

[0020] At least one signal line connected to the input and output terminals of high-frequency signals may be formed in a region not overlapping the first ground electrode on the power supply line layer in a lamination direction. Even when there are signal lines on a dielectric layer having the power supply line layer, interference between the power supply lines and the signal lines can be prevented by arranging the signal lines in a region other than the region in which the other ends of the power supply lines are gathered (region not overlapping the first ground electrode).

[0021] Some of the power supply lines preferably are constituted by a first line portion formed on the opposite side of the power supply line layer with respect to the second ground electrode, and second line portions formed on the power supply line layer and connected to both ends of the first line portion through via-electrodes, the first line portion crossing the other power supply lines on the power supply line layer when viewed from above in a lamination direction.

[0022] The high-frequency device preferably comprises a power supply terminal common to pluralities of amplifier circuits. This structure enables the miniaturization of the high-frequency device.

[0023] The high-frequency device preferably comprises a low-noise amplifier circuit as the amplifier circuit, one power supply terminal being commonly used for the switch circuits and the low-noise amplifier circuit. This structure enables the miniaturization of the high-frequency device, and the synchronization of the switch circuits and the low-noise amplifier circuit.

[0024] The input and output terminals of high-frequency signals and the power supply terminals preferably are arranged via other terminals. This structure can suppress interference between the power supply terminals and the input and output terminals of high-frequency signals.

[0025] It is preferable that the switch circuit switches the connection of an antenna terminal to the input and output terminals of the high-frequency signals, and that the amplifier circuit comprises a high-frequency amplifier circuit for amplifying transmitting signals input to the input terminal, and/or a low-noise amplifier circuit for amplifying received signals input through the antenna terminal.

[0026] The communications apparatus of the present invention comprises the above high-frequency device. With the above high-frequency device, the communications apparatus can be miniaturized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

Fig. 1 is a development view showing part of the high-frequency device according to one embodiment of the present invention.

Fig. 2 is a development view showing part of the high-frequency device according to another embodiment of the present invention.

Fig. 3 is a block diagram showing the circuit of the high-frequency device according to one embodiment of the present invention.

Fig. 4 is a block diagram showing the circuit of the high-frequency device according to another embodiment of the present invention.

Fig. 5 is a development view showing part of the high-frequency device according to a further embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] The high-frequency device of the present invention is a laminate substrate comprising pluralities of dielectric layers having conductor patterns, which has high-frequency-signal-treating circuits. The high-frequency-signal-treating circuits include a switch circuit for switching high-frequency signals paths, an amplifier circuit such as a semiconductor element for amplifying high-frequency signals, etc. The switch circuit is preferably an FET (field-effect transistor) switch such as a Ga-As switch, etc., which has two or more drive power supplies and/or control power supplies in total. The amplifier circuit is preferably a high-frequency amplifier circuit for amplifying transmitting signals, a low-noise amplifier circuit for amplifying received signals, etc., which has two or more drive power supplies and/or control power supplies in total. The high-frequency amplifier circuit may have a detection circuit for monitoring output power. Because the output signal of the detection circuit is DC voltage, it can be treated like a power supply line. Explanation will be made below with respect to an example having both high-frequency amplifier circuit and low-noise amplifier circuit, without intension of restriction.

[0029] The high-frequency device according to one embodiment of the present invention has a laminate substrate comprising 20 dielectric layers on which conductor patterns constituting the circuit shown in Fig. 3 are formed. Fig. 1 shows electrode patterns arranged on three lowest layers in the above laminate substrate, and terminals (input and output terminals of high-frequency signals, and power supply terminals for high-frequency-signal-treating circuits) arranged on one main surface (rear surface) along its edges at high density. The arrangement of terminals on the rear surface are viewed from above in a lamination direction.

[0030] The circuit for treating high-frequency signals shown in Fig. 3 is a one-transmission-one-reception-type, dual-band wireless LAN front-end module, which comprises an antenna terminal Ant1 connected to an antenna, a first switch circuit SPDT1 connected to the antenna terminal Ant1 for switching the connection of input terminals (transmission terminals) Tx1-1, Tx2-1 and output terminals (reception terminals) Rx1-1, Rx2-1 for high-frequency signals, a first high-frequency amplifier circuit PA1 for amplifying high-frequency transmitting signals input to the input terminal Tx1-1, a second high-frequency amplifier circuit PA2 for amplifying transmitting signals input to the input terminal Tx2-1, and a first low-noise amplifier circuit LNA1 for amplifying received signals input through the antenna terminal Ant1 and output to the output terminal Rx1-1 or Rx2-1. A first diplexer circuit Dip1 is connected to the first switch circuit SPDT1. The first diplexer circuit comprises a lower-frequency-side filter and a higher-frequency-side filter, the lower-frequency-side filter being connected to a first lowpass filter LPF1, the first detection circuit DET1, the first high-frequency amplifier circuit PA1, a first bandpass filter BPF1, a first balanced-to-unbalanced conversion circuit BAL1 and the input terminal Tx1-1 in this order, and the higher-frequency-side filter being connected to a second lowpass filter LPF2, a second detection circuit DET2, the second high-frequency amplifier circuit PA2, a second bandpass filter BPF2, a second balanced-to-unbalanced conversion circuit BAL2 and the input terminal Tx2-1 in this order. The first switch circuit SPDT1 is connected to a second diplexer circuit Dip2 via a parallel circuit comprising the first low-noise amplifier circuit LNA1 and a first bypass switch circuit BypSW1. The second diplexer circuit comprises a lower-frequency-side filter and a higher-frequency-side filter, the lower-frequency-side filter being connected to a third bandpass filter BPF3 and the output terminal Rx1-1 in this order, and the higher-frequency-side filter being connected to a fourth bandpass filter BPF4 and the output terminal Rx2-1 in this order.

[0031] As shown in Fig. 1, terminals including the input and output terminals of high-frequency signals (represented by RF together with the antenna terminal), and the power supply terminals Vtx1, Vrx1, Vcc, Vab, Vgb, Vpd, VccL, VbL1, Vby1 of the high-frequency-signal-treating circuits are formed on the rear surface of the laminate substrate. NC represents dummy terminals. Because the detection output terminals Vpd of the detection circuits DENT1, DET2 are on a DC signal line, they are included in power supply terminals for convenience. The power supply terminals Vtx1, Vrx1 are terminals for controlling the first switch circuit SPDT1. For instance, when 3 V and 0 V are respectively applied to Vtx1 and Vrx1, the first switch circuit SPDT1 is controlled such that the first antenna terminal Ant1 is connected to the input terminals Tx1-1, Tx2-1 for high-frequency signals. Also when 0 V and 3 V are respectively applied to Vtx1 and Vrx1, the first switch circuit SPDT1 is controlled such that the first antenna terminal Ant1 is connected to the output terminals Rx1-1, Rx2-1 for high-frequency signals.

[0032] The power supply terminal Vcc is a common

power supply terminal for the first and second high-frequency amplifier circuits PA1 and PA2. With one power supply terminal commonly used for pluralities of amplifier circuits, the number of terminals is reduced, enabling the miniaturization of the high-frequency device. The power supply terminal Vgb is a power supply terminal used for controlling the ON/OFF of the first high-frequency amplifier circuit PA1. For instance, when 2.8 V is applied to Vgb with 3.3 V applied to the power supply terminal Vcc, the first high-frequency amplifier circuit PA1 is turned on to amplify the input high-frequency signals. The power supply terminal Vab is a power supply terminal used for controlling the ON/OFF of the second high-frequency amplifier circuit PA2. For instance, when 2.8 V is applied to Vab with 3.3 V applied to the power supply terminal Vcc, the second high-frequency amplifier circuit PA2 is turned on to amplify the input high-frequency signals.

[0033] The power supply terminal VccL is a drive power supply terminal for the first low-noise amplifier circuit LNA1. The power supply terminal VbL1 is a common terminal used for controlling the ON/OFF of the first low-noise amplifier circuit LNA1 and controlling the first bypass switch circuit BypSW1. With a common power supply terminal for the switch circuit and the low-noise amplifier circuit connected thereto, the number of terminals is reduced, enabling the miniaturization of the high-frequency device. The power supply terminal Vby1 also is a terminal used for controlling the first bypass switch circuit BypSW1. For instance, when 3 V and 0 V are respectively applied to VbL1 and Vby1, the first bypass switch circuit BypSW1 is controlled, such that the input side of the first low-noise amplifier circuit LNA1 is connected to the first switch circuit SPDT1, and that the output side of the first low-noise amplifier circuit LNA1 is connected to the second diplexer circuit Dip2. In this case, when 3 V is applied to VccL, the first low-noise amplifier circuit LNA1 is turned on to amplify the input high-frequency signals. Also, when 0 V and 3 V are respectively applied to VbL1 and Vby1, the first bypass switch circuit BypSW1 is controlled, such that the first switch circuit SPDT1 is connected to the second diplexer circuit Dip2 without passing the first low-noise amplifier circuit LNA1. In this case, even when 3 V is applied to VccL, the first low-noise amplifier circuit LNA1 is in an OFF state, because 0 V is applied to VbL1 connected to the first low-noise amplifier circuit LNA1.

[0034] Formed on a dielectric layer DL1 are a power supply line lvab having one end connected to the power supply terminal Vab of the amplifier circuit, a power supply line lvrx1 having one end connected to the power supply terminal Vrx1 of the switch circuit, and a power supply line lvtx1 having one end connected to the power supply terminal Vtx1 of the switch circuit. Each power supply line lvrx1, lvtx1 has a first line portion (indicated as lvrx1 and lvtx1 in DL3) formed on the layer DL3 on the opposite side of the power supply line layer with respect to the second ground electrode GND2, and two second line portions formed on the power supply line layer and connected to both ends of the first line portion through via-electrodes. Likewise, a DC signal line lvpd having one end connected to the detection output terminal Vpd also has a first line portion formed on the layer DL3 on the opposite side of the power supply line layer with respect to the second ground electrode GND2, and two second line portions formed on the power supply line layer and connected to both ends of the first line portion through via-electrodes. The connected first and second line portions constitute one power supply line. Accordingly, the power supply line layer on the dielectric layer DL1 has three power supply lines. If the DC signal line lvpd having one end connected to the detection output terminal Vpd is included in the power supply line for convenience, the power supply line layer on the dielectric layer DL1 has four power supply lines.

[0035] The first line portion of the power supply line lvtx1 is crossing the power supply line lvtx1 on the power supply line layer, when viewed in a lamination direction. The first line portion of the power supply line lvpd is crossing the power supply line lvab on the power supply line layer, when viewed in a lamination direction. Only first portions crossing the power supply lines are arranged on the opposite side of the power supply line layer with respect to the second ground electrode, and second portions on both sides thereof are arranged on the power supply line layer, thereby suppressing interference with other electrodes such as grounded capacitance electrodes, etc. Such structure is suitable when the power supply lines cannot avoid crossing. In this case, a third ground electrode is preferably arranged on a layer on the opposite side of the second ground electrode with respect to the first line portions, such that the third ground electrode overlaps the first line portions. For instance, a wide ground electrode like the second ground electrode may be formed on a layer DL4 (not shown) adjacent to DL3. With electrode patterns for grounded capacitors for high-frequency treating circuits formed on the layer DL3 sandwiched by the ground electrodes as shown in Fig. 1, the high-frequency device can be miniaturized.

[0036] A first ground electrode GND1 overlapping at least part of the above power supply lines in a lamination direction is formed on the rear surface, and a second ground electrode GND2 overlapping at least part of the above power supply lines in a lamination direction is formed on the upper dielectric layer DL2. In this example, the first and second ground electrodes GND1, GND2 cover substantially the entire power supply line layer. High-frequency-signal-treating circuits such as the first switch circuit SPDT1, the first and second high-frequency amplifier circuits PA1, PA2, the low-noise amplifier circuit LNA1, etc. are arranged above the dielectric layer DL3 on the opposite side of the power supply line layer with respect to the second ground electrode GND2. The high-frequency signal lines are connected to conductor patterns above the second ground electrode GND2 through via-electrodes. Accordingly, the high-frequency signal lines are not formed on the power supply line layers, ex-

cept for electrodes accompanying the via-electrodes (electrodes formed around the via-electrodes in connection with their formation, etc.). Some of the power supply terminals are connected directly to the high-frequency-signal-treating circuits through via-electrodes. With the power supply line layer sandwiched by a pair of ground electrodes without interposing other layers having high-frequency signal lines, the arrangement of the power supply lines has a high degree of freedom with suppressed interference between the power supply lines and signal lines, thereby contributing to the miniaturization of the high-frequency device.

[0037] As described above, the drive power supply lines and control power supply lines of the high-frequency-signal-treating circuits, and the DC signal lines of the detection output terminals are formed on the power supply line layer. Power supply lines lvrx1, lvtx1, lvab, lvpd each having one end connected to each power supply terminal Vrx1, Vtx1, Vab, Vpd are bent on the power supply line layer, with their other ends connected to the high-frequency-signal-treating circuits on an upper layer through via-electrodes distant from the above power supply terminals. As a result, there can be larger gaps between the other ends of the power supply lines than between the power supply terminals and the input/output terminals of signals. If necessary, the power supply lines may extend to the high-frequency-signal-treating circuits above the second ground electrode GND2.

[0038] When a choke coil is formed by power supply lines that can be arranged without restriction in the power supply line layer, high-frequency noise can be removed from the power supply lines upstream of the high-frequency-signal-treating circuits. Via-electrodes are formed in the notches and gaps of the second ground electrode GND2. The first ground electrode GND1 is preferably formed on a rear surface of a portion of the dielectric layer DL1 overlapping the notches and gaps of the second ground electrode GND2 in a lamination direction, to prevent interference with the outside.

[0039] To prevent interference between the power supply terminals and the signal terminals, the terminals RF and the power supply terminals are arranged via other terminals such as ground terminals G, dummy terminals NC, etc. A first, rectangular ground electrode GND1 having a large area is arranged inside the terminals on the rear surface. Gaps between the first ground electrode GND1 and the terminals are substantially the same as the terminal gaps. Although the first ground electrode GND1 may be formed in the laminate substrate, its formation on the rear surface having terminals makes the height of the high-frequency device smaller. Because some power supply terminals Vab, Vpd, Vtx1, Vrx1 overlap the second ground electrode GND2 in a lamination direction, it is possible to suppress interference between these power supply terminals and the high-frequency-signal-treating circuits above the second ground electrode GND2.

[0040] To suppress interference between the signal terminals and the signal lines, the power supply terminals are preferably arranged in a gathered manner. Accordingly, some of the power supply terminals Vtx1, Vrx1 are adjacent to each other. The power supply terminals also are arranged on the opposing sides of the rectangular rear surface (upper and lower sides in Fig. 1). This makes it possible to gather high-frequency signal terminals such as the input/output terminals, the antenna terminal, etc. on the other opposing sides (lateral sides in Fig. 1), suppressing interference between the power supply terminals and the high-frequency signal terminals. In conventional high-frequency devices, the gathering of power supply terminals provides a structure in which the wiring of elements mounted on the surface are entangled with high-frequency signal lines, sacrificing the isolation of power supply lines from high-frequency signal lines or the size of the high-frequency device. However, with the power supply line layer sandwiched by ground electrodes, the power supply terminals can be arranged in a gathered manner, securing isolation between the power supply lines and the high-frequency signal lines.

[0041] Gaps between the other ends of the power supply lines can be larger than those between adjacent power supply terminals. Both ends of the power supply lines can be positioned on different sides, enabling the complicated arrangement of long power supply lines, and thus achieving the isolation of power supply lines from high-frequency signal lines and the miniaturization of the high-frequency device.

[0042] As shown in Fig. 1, when the power supply line layer is divided to four triangular regions with two diagonal lines, the power supply lines lvpd extend in four regions, the power supply lines lvab and lvrx1 extend in three regions, and the power supply lines lvtx1 extend in two regions. Because switch circuits and amplifier circuits are mostly arranged on the entire mounting surface, it is likely that their connecting terminals are largely distant from the power supply terminals. In this case, when the power supply lines are formed on a dielectric layer having the high-frequency signal lines, interference occurs between the high-frequency signal lines and the power supply lines. Avoiding such interference provides a larger high-frequency device. On the other hand, when long power supply lines extend in two or more of triangular regions obtained by diagonally quartering the power supply line layer as shown in Fig. 1, power supply lines connected to the power supply terminals arranged on one side of the rear surface can extend close to the other side. As a result, even when the power supply terminals are gathered on one side, the arrangement of the power supply lines has an extremely high degree of freedom, preventing interference between the high-frequency signal lines and the power supply lines without making the high-frequency device larger. At least one power supply line preferably extends in three or more of the quartered triangular regions.

[0043] On the dielectric layer DL1, via-electrodes (indicated by small circles) are arranged between the power

supply line lvab of the amplifier circuit, whose one end is connected to the power supply terminal Vab, and the power supply line lvtx1 of the switch circuit, whose one end is connected to the power supply terminal Vtx1. The via-electrodes are connected to the first and second ground electrodes GND1, GND2, suppressing interference between the power supply line of the amplifier circuit and the power supply line of the switch circuit.

[0044] The high-frequency device according to another embodiment of the present invention shown in Fig. 2 has a laminate substrate comprising 24 dielectric layers, on which conductor patterns constituting the high-frequency circuit shown in Fig. 4 are formed. Fig. 2 shows electrode patterns formed on three lowest layers and terminals formed on the rear surface. The arrangement of the terminals on the rear surface is viewed from above in a lamination direction.

[0045] The high-frequency circuit shown in Fig. 4 is a one-transmission-two-reception-type, dual-band wireless LAN front-end module constituted by adding a high-frequency sub-circuit (called "second high-frequency sub-circuit" below) as a receiving path to the high-frequency circuit shown in Fig. 3. Because a portion other than the second high-frequency sub-circuit, which is called "first high-frequency sub-circuit" below, has the same structure as shown in Fig. 3, its explanation will be omitted. The second high-frequency sub-circuit comprises a second antenna terminal Ant2 connected to a second antenna different from the first antenna for the first high-frequency sub-circuit, and a second low-noise amplifier circuit LNA2 for amplifying received signals input through the second antenna terminal Ant2 and output to the terminal Rx1-2 or Rx2-2. The antenna terminal Ant2 is connected to the second switch circuit SPDT2, which is connected to a third diplexer circuit Dip3 via a parallel circuit comprising the second low-noise amplifier circuit LNA2 and a second bypass switch circuit BypSW2. The third diplexer circuit comprises a lower-frequency-side filter and a higher-frequency-side filter, the lower-frequency-side filter being connected to a fifth bandpass filter BPF5 and the output terminal Rx1-2 in this order, and the higher-frequency-side filter being connected to a sixth bandpass filter BPF6 and the output terminal Rx2-2 in this order. Another terminal of the second switch circuit SPDT2 is connected to an input/output terminal TxRx.

[0046] As shown in Fig. 2, terminals including the input and output terminals of high-frequency signals (indicated by RF together with the antenna terminal), and the power supply terminals Vtx1, Vrx1, Vcc, Vab, Vgb, Vpd, VccL, VbL1, Vby1, Vtx2, Vrx2, VbL2, Vby2 of the high-frequency-signal-treating circuits are formed on the rear surface of the laminate substrate. Because the power supply terminals Vtx1, Vrx1, Vcc, Vab, Vgb, Vpd, VbL1, Vby1 are the same as shown in Fig. 3, their explanation will be omitted. The power supply terminals Vtx2 and Vrx2 are those used for controlling the second switch circuit SPDT2. For instance, when 3 V and 0 V are respectively applied to Vtx2 and Vrx2, the second switch circuit SPDT2 is controlled, such that the second antenna terminal Ant2 is connected to the input/output terminal TxRx of high-frequency signals. When 0 V and 3 V are respectively applied to Vtx2 and Vrx2, the second switch circuit SPDT2 is controlled, such that the second antenna terminal Ant2 is connected to the output terminals Rx1-2 and Rx2-2 of high-frequency signals.

[0047] The power supply terminal VccL is a common drive power supply terminal for the first and second low-noise amplifier circuits LNA1 and LNA2. The power supply terminal VbL2 is a common power supply terminal used for controlling the ON/OFF of the second low-noise amplifier circuit LNA2 and controlling the second bypass switch circuit BypSW2. The power supply terminal Vby2 also is a power supply terminal used for controlling the second bypass switch circuit BypSW2. For instance, when 3 V and 0 V are respectively applied to VbL2 and Vby2, the second bypass switch circuit BypSW2 is controlled, such that the input side of the second low-noise amplifier circuit LNA2 is connected to the second switch circuit SPDT2, and that the output side of the second low-noise amplifier circuit LNA2 is connected to the third diplexer circuit Dip3. In this case, when 3 V is applied to VccL, the second low-noise amplifier circuit LNA2 is in an ON state, amplifying the input high-frequency signals. When 0 V and 3 V are respectively applied to VbL2 and Vby2, the second bypass switch circuit BypSW2 is controlled, such that the second switch circuit SPDT2 is connected to the third diplexer circuit Dip3 without passing the second low-noise amplifier circuit LNA2. In this case, even when 3 V is applied to VccL, the second low-noise amplifier circuit LNA2 is in an OFF state because 0 V is applied to VbL2 connected to the control voltage terminal of the second low-noise amplifier circuit LNA2. With a power supply terminal commonly used for the switch circuit and the low-noise amplifier circuit, the number of terminals is reduced, making it easy to control the switch circuit and the low-noise amplifier circuit.

[0048] The power supply lines lvrx1, lvtx1, lvrx2, lvtx2, lvcc, lvab, lvccL, lvpd1, lvby1, lvbL1 and lvby2 each having one end connected to each of the power supply terminals Vrx1, Vtx1, Vrx2, Vtx2, Vcc, Vab, VccL, Vpd, Vby1, VbL1 and Vby2 are formed on one dielectric layer DL1 to constitute a power supply line layer. The first ground electrode GND1 overlapping at least part of the power supply lines in a lamination direction is formed on the rear surface of the laminate substrate, and the second ground electrode GND2 overlapping at least part of the power supply lines in a lamination direction is formed on a dielectric layer DL2 (on the opposite side of the rear surface in a lamination direction) above the dielectric layer DL1. High-frequency-signal-treating circuits such as the switch circuits SPDT1, SPDT2, the high-frequency amplifier circuits PA1, PA2, the low-noise amplifier circuits LNA1, LNA2, etc. are arranged on layers (on the opposite side of the power supply line layer via the second ground electrode GND2) above the dielectric layer

DL3.

[0049] With the first and second low-noise amplifier circuits LNA1, LNA2 commonly using the power supply line lvccL connected to the power supply terminal VccL, the miniaturization of the high-frequency device is achieved due to the reduction of the number of power supply lines, and interference is suppressed. The first low-noise amplifier circuit LNA1 and the first bypass switch circuit BypSW1 commonly use the power supply line lvbL1 connected to the power supply terminal VbL1. The commonly used power supply line may be branched on a layer above the power supply line layer or the second ground electrode. Although a switch circuit commonly using the low-noise amplifier circuit and the power supply terminal is a bypass switch circuit in the embodiment shown in Figs. 2 and 4, the switch circuit SPDT1 connected to the antenna terminal Ant1 for switching transmission and reception and the low-noise amplifier circuit LNA1may commonly use a power supply terminal. Likewise, the switch circuit SPDT2 connected to the antenna terminal Ant2 for switching transmission and reception and the low-noise amplifier circuit LNA2 may commonly use a power supply terminal.

[0050] The power supply lines lvrx1, etc. each having one end connected to each of the power supply terminals Vrx1, etc. extend from the power supply terminals while being bent on the power supply line layer, and their other ends are connected to the high-frequency-signal-treating circuits on upper layers through via-electrodes distant from the above power supply terminals. As in the embodiment shown in Fig. 1, the power supply terminals of the amplifier circuits and some of the power supply terminals VccL, Vrx1, Vtx1, Vrx2, Vtx2, Vcc and Vab of the switch circuits are adjacent to each other. The power supply terminals are arranged on opposing sides (upper and lower sides in Fig. 2) of the rectangular rear surface. With this structure, high-frequency signal terminals such as input terminals, output terminals, antenna terminals, etc. can be gathered on the other opposing sides (lateral sides in Fig. 2), suppressing interference between the power supply terminals and the high-frequency signal terminals.

[0051] On the dielectric layer DL1, via-electrodes (shown by small circles) are arranged between the power supply lines lvtx1, lvrx2 of different switch circuits, etc. The via-electrodes are connected to the first and second ground electrodes GND1, GND2, suppressing interference between the power supply lines of the amplifier circuits and the power supply lines of the switch circuits. The arrangement effects of the power supply lines and the power supply terminals are the same as in the embodiment shown in Fig. 1.

[0052] In the embodiment shown in Figs. 2 and 4, the power supply line layer has 11 power supply lines connected to the high-frequency amplifier circuits, the low-noise amplifier circuits and the switch circuits. Some of the power supply lines are as long as half or more of one side of the rear surface. The power supply line layer ensures a high degree of freedom in the arrangement of a large number of power supply lines. As in Fig. 1, pluralities of power supply lines extend in two or more of triangular regions obtained by diagonally quartering the power supply line layer. Specifically, the power supply lines lvrx1 extend in three triangular regions, and the power supply lines lvtx1, lvrx2, lvtx2, lvccL and lvpd1 extend in two triangular regions.

[0053] Fig. 5 shows a high-frequency device according to a further embodiment of the present invention. This high-frequency device is a one-transmission-one-reception-type, dual-band, wireless LAN front-end module comprising the same high-frequency circuits as in the embodiments shown in Figs. 1 and 3. Fig. 5 shows electrode patterns formed on three lowest layers and terminals on a rear surface. The arrangement of terminals on the rear surface is viewed from above in a lamination direction.

[0054] Power supply lines lvrx1, lvtx1, lvcc, lvab, lvgb, lvccL and lvbL1 each having one end connected to each of the power supply terminals Vrx1, Vtx1, Vcc, Vab, Vgb, VccL and VbL1 and the detection output terminals Vpd, and a DC signal line lvpd are formed on a dielectric layer DL1 to constitute a power supply line layer. As in Fig. 1, pluralities of power supply lines extend in two or more of triangular regions obtained by diagonally quartering the power supply line layer. Specifically, the power supply line lvbL1 extends in three regions, and the power supply lines lvab, lvgb and lvtx1 extend in two regions.

[0055] The embodiment shown in Fig. 5 differs from the first embodiment in that signal lines 1btx, 1brx and 1arx connected to the input or output terminal of high-frequency signals are formed on the power supply line layer. These signal lines are formed in a region that does not overlap the first ground electrode GND1 in a lamination direction. In this structure, the signal lines are distant from a region overlapping the first ground electrode GND1, in which the other ends of the power supply lines gather, preventing interference between the signal lines and the power supply lines. To prevent interference between the signal lines and the power supply lines surely, however, it is advantageous to form only power supply lines on the power supply line layer.

[0056] The high-frequency device of the present invention is constituted by a laminate substrate (ceramic laminate substrate device), which can be formed, for instance, by printing each green sheet as thick as 10-200 μm made of dielectric ceramics sinterable at as low temperatures as 1000°C or lower (LTCC, low-temperature-co-fired ceramics) with a conductive paste of low-resistivity Ag, Cu, etc. to form electrode patterns constituting the above high-frequency circuits, integrally laminating and sintering them. The dielectric ceramics preferably have, for instance, (a) a composition comprising Al, Si and Sr as main components, and Ti, Bi, Cu, Mn, Na, K, etc. as sub-components, (b) a composition comprising Al, Si and Sr as main components, and Ca, Pb, Na, K, etc. as sub-components, (c) a composition comprising

Al, Mg, Si and Gd, or (d) a composition comprising Al, Si, Zr and Mg. The dielectric ceramics preferably have dielectric constants of about 5-15. Apart from the dielectric ceramics, resins or composite materials of resins and dielectric ceramic powder may be used. Patterns of high-temperature-sinterable metals such as tungsten, molybdenum, etc. may be formed on an alumina-based, dielectric ceramic substrate, and integrally sintered according to an HTCC (high-temperature-co-fired ceramic) technology.

[0057] When the high-frequency device such as a front-end module, etc. is constituted by the ceramic laminate substrate, electrode patterns for inductance elements, capacitance elements, power supply lines and ground electrodes, and via-electrodes are formed on each layer. Mainly, diplexer circuits, bandpass filter circuits, lowpass filter circuits and balanced-to-unbalanced conversion circuits are formed in the ceramic laminate substrate. Semiconductor elements for single-pole, double-throw switches (SPDT switches or diode switches), high-frequency amplifier circuits PA, chip capacitors, chip resistors and chip inductors for low-noise amplifier circuits LNA, etc. mounted on the ceramic laminate substrate are connected to electrode patterns in the ceramic laminate substrate by wire-bonding, LGA, BGA, etc.

[0058] Pluralities of ceramic green sheets having electrode patterns of Ag were integrally laminated, and sintered at about 900°C to form a laminate substrate, on which semiconductor elements for switch circuits, high-frequency amplifier circuits and low-noise amplifiers, chip capacitors, chip resistors and chip inductors are mounted, to obtain the high-frequency device of 7 mm x 7 mm x 1.4 mm according to the embodiment shown in Fig. 1. This high-frequency device was 25% smaller than those having power supply lines without a power supply line layer, providing a front-end module with less interference between power supply lines and RF circuits, and improved characteristics.

[0059] The high-frequency device of the present invention is suitable for wireless communications apparatuses of a MIMO (multi-input, multi-output) type needing many signal lines and power supply lines. The MIMO type includes a SIMO (single-input, multi-output) type such as a one-transmission, two-reception type. The above high-frequency device contributes to the miniaturization and cost reduction of communications apparatuses. The above high-frequency device can be used widely for mobile equipments, personal computers, etc. having wireless communications functions.

EFFECT OF THE INVENTION

[0060] The high-frequency device of the present invention having high-frequency-signal-treating circuits in and on a laminate substrate comprising pluralities of dielectric layers having conductor patterns has reduced interference between power supply lines and signal lines, and can be miniaturized without deteriorating high-frequency characteristics. The use of such high-frequency devices provides the miniaturization of communications apparatuses.

Claims

1. A high-frequency device having high-frequency-signal-treating circuits (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) in and on a laminate substrate comprising pluralities of dielectric layers (DL1-3) having conductor patterns,

said high-frequency-signal-treating circuits (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) having amplifier circuits (PA1-2, LNA1-2) and switch circuits (SPDT1-2, BypSW1-2);

terminals (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) including input and output terminals (Tx, Rx) of high-frequency signals, power supply terminals (Vcc, Vab, VccL) of said amplifier circuits (PA1-2, LNA1-2) and power supply terminals (Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) of said switch circuits (SPDT1-2, BypSW1-2) being formed on one main surface of said laminate substrate;

power supply lines (lvab, lvccL) each having one end connected to each of the power supply terminals (Vcc, Vab, VccL) of said amplifier circuits (PA1-2, LNA1-2) and power supply lines (lvtx1-2, lvrx1-2) each having one end connected to the power supply terminals (Vtx1-2, Vrx1-2) of said switch circuits (SPDT1-2, BypSW1-2) being formed on one dielectric layer to constitute a power supply line layer (DL1);

a first ground electrode (GND1) being arranged on said main surface with respect to said power supply line layer (DL1), said first ground electrode (GND1) overlapping at least part of said power supply lines (lvab, lvccL, lvtxl-2, lvrx1-2) in a lamination direction;

a second ground electrode (GND2) being arranged on the opposite side of said first ground electrode (GND1) with respect to said power supply line layer (DL1), said second ground electrode (GND2) overlapping at least part of said power supply lines (lvab, lvccL, lvtx1-2, lvrx1-2) in a lamination direction;

said power supply line layer (DL1) being sandwiched by said first ground electrode (GND1) and said second ground electrode (GND2) without interposing any other ground electrode;

via-electrodes connected to said first and second ground electrodes (GND 1, GND2) being arranged between said power supply lines (lvab, lvccL) of said amplifier circuits (PA1-2, LNA1-2) and said power supply lines (lvtxl-2, lvrx1-2) of said switch circuits (SPDT1-2, BypSW1-2); and

said high-frequency-signal-treating circuits (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) being arranged on the opposite side of said power supply line layer (DL1) with respect to said second ground electrode (GND2).

2. The high-frequency device according to claim 1, wherein
said dielectric layer (DL1) is rectangular,
said switch circuit (SPDT1-2, BypSW1-2) is adapted to switch the connection of an antenna terminal (Ant1-2) to the input and output terminals (Tx, Rx) of said high-frequency signals,
said terminals (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) are arranged along the edges of said main surface, with said first ground electrode (GND1) inside said terminals (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) on said main surface,
said power supply terminals (Vcc, Vab, VccL) of said amplifier circuits (PA1-2, LNA1-2) and said power supply terminals (Vtx1-2, Vrx1-2) of said switch circuits (SPDT1-2, BypSW1-2) are arranged on two opposing sides of said main surface, and
said input and output terminals (Tx, Rx) and said antenna terminal (Ant1-2) are arranged on the other two opposing sides of said main surface.

3. The high-frequency device according to claim 1 or 2, wherein at least part of said power supply terminals (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) overlap said second ground electrode (GND2) in a lamination direction.

4. The high-frequency device according to any one of claims 1-3, wherein said other ends of the power supply lines (lvab, lvccL, lvtx1-2, lvrx1-2) are connected to said high-frequency-signal-treating circuits (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) through via-electrodes formed in a region overlapping said first ground electrode (GND1) in a lamination direction.

5. The high-frequency device according to any one of claims 1-4, wherein at least part of the power supply terminals (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) are adjacent to each other.

6. The high-frequency device according to any one of claims 1-5, wherein signal lines connected to said input and output terminals (Tx, Rx) of high-frequency signals are not formed on said power supply line layer (DL1).

7. The high-frequency device according to claim 1, wherein at least one signal line connected to said input and output terminals (Tx, Rx) of high-frequency signals are formed in a region not overlapping said first ground electrode (GND1) on said power supply line layer (DL1) in a lamination direction.

8. The high-frequency device according to any one of claims 1-7, wherein some of said power supply lines (lvrx1, lvtx1) are constituted by a first line portion formed on the opposite side of said power supply line layer (DL1) with respect to said second ground electrode (GND2), and second line portions formed on said power supply line layer (DL1) and connected to both ends of the first line portion through via-electrodes, said first line portion crossing the other power supply lines on said power supply line layer (DL1) when viewed from above in a lamination direction.

9. The high-frequency device according to any one of claims 1-8, comprising a power supply terminal (Vcc, VccL) common to pluralities of amplifier circuits (PA1-2, LNA1-2).

10. The high-frequency device according to any one of claims 1-9, comprising a low-noise amplifier circuit (LNA1-2) as said amplifier circuit, one power supply terminal (VbL1-2) being commonly used for said switch circuits (BypSW1-2) and said low-noise amplifier circuit (LNA1-2).

11. The high-frequency device according to any one of claims 1-10, wherein pluralities of power supply lines (lvab, lvtx1-2, lvrx1-2) extend in two or more of triangular regions obtained by diagonally quartering the dielectric layer having said power supply line layer (DL1).

12. The high-frequency device according to any one of claims 1-11, wherein said input and output terminals (Tx, Rx) of high-frequency signals and said power supply terminals (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) are arranged via other terminals.

13. The high-frequency device according to any one of claims 1-12, wherein said amplifier circuit (PA1-2, LNA1-2) comprises
a high-frequency amplifier circuit (PA1-2) for amplifying transmitting signals input to said input terminal (Tx), and/or
a low-noise amplifier circuit (LNA1-2) for amplifying received signals input through said antenna terminal (Ant1-2).

14. The high frequency device according to any one of claims 1-13, wherein some of said power supply lines (lvab, lvccL, lvtx1-2, lvrx1-2) are as long as half or more of one side of the rear surface of said laminate substrate.

15. A communications apparatus comprising the high-frequency device recited in any one of claims 1-14.

Patentansprüche

1. Hochfrequenzvorrichtung mit Hochfrequenzsignal-

behandlungsschaltungen (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) in und auf einem Schichtsubstrat mit mehreren dielektrischen Lagen (DL1-3), die Leitungsmuster aufweisen, wobei

die Hochfrequenzsignalbehandlungsschaltungen (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) Verstärkerschaltungen (PA1-2, LNA1-2) und Umschaltschaltungen (SPDT1-2, BypSW1-2) aufweisen,

Endanschlüsse (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrxl-2, VbL1-2, Vby1-2) mit Eingabe- und Ausgabeanschlüssen (Tx, Rx) von Hochfrequenzsignalen, Leistungsversorgungsanschlüssen (Vcc, Vab, VccL) der Verstärkerschaltungen (PA1-2, LNA1-2) und Leistungsversorgungsanschlüssen (Vtx1-2, Vrx1-2, VbL1-2, Vby1-2) der Umschaltschaltungen (SPDT1-2, BypSW1-2) auf einer Hauptfläche des Schichtsubstrats gebildet sind,

Leistungsversorgungsleitungen (lvab, lvccL), die jeweils mit einem Ende an jeden der Leistungsversorgungsanschlüsse (Vcc, Vab, VccL) der Verstärkerschaltungen (PA1-2, LNA1-2) angeschlossen sind, und Leistungsversorgungsleitungen (lvtx1-2, lvrx1-2), die jeweils mit einem Ende an die Leistungsversorgungsanschlüsse (Vtxl-2, Vrx1-2) der Umschaltschaltungen (SPDT1-2, BypSW1-2) angeschlossen sind, auf einer dielektrischen Lage gebildet sind, um eine Leistungsversorgungsleitungslage (DL1) aufzubauen,

eine erste Erdungselektrode (GND1) auf der Hauptfläche bezüglich der Leistungsversorgungsleitungslage (DL1) angeordnet ist, wobei die erste Erdungselektrode (GND1) wenigstens einen Teil der Leistungsversorgungsleitungen (lvab, lvccL, lvtx1-2, lvrx1-2) in einer Schichtungsrichtung überlappt,

eine zweite Erdungselektrode (GND2) auf der entgegengesetzten Seite der ersten Erdungselektrode (GND1) bezüglich der Leistungsversorgungsleitungslage (DL1) angeordnet ist, wobei die zweite Erdungselektrode (GND2) wenigstens einen Teil der Leistungsversorgungsleitungen (lvab, lvccL, lvtx1-2, lvrx1-2) in einer Schichtungsrichtung überlappt,

die Leistungsversorgungsleitungslage (DL1) zwischen der ersten Erdungselektrode (GND1) und der zweiten Erdungselektrode (GND2) liegt, ohne dass dazwischen irgendeine andere Erdungselektrode ist,

an die erste und die zweite Erdungselektrode (GND1, GND2) angeschlossene Durchgangselektroden zwischen den Leistungsversorgungsleitungen (lvab, lvccL) der Verstärkerschaltungen (PA 1-2, LNA1-2) und den Leistungsversorgungsleitungen (lvtx1-2, lvrx1-2) der Umschaltschaltungen (SPDT1-2, BypSW1-2) angeordnet sind, und

die Hochfrequenzsignalbehandlungsschaltungen (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) auf der entgegengesetzten Seite der Leistungsversorgungsleitungslage (DL1) bezüglich der zweiten Erdungselektrode (GND2) angeordnet sind.

2. Hochfrequenzvorrichtung nach Anspruch 1, wobei die dielektrische Lage (DL1) rechtwinklig ist,

die Umschaltschaltung (SPDT1-2, BypSW1-2 dazu ausgelegt ist, die Verbindung eines Antennenanschlusses (Ant1-2) an die Eingabe- und Ausgabeanschlüsse (Tx, Rx) von Hochfrequenzsignalen umzuschalten,

die Anschlüsse (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrxl-2, VbL1-2, Vby1-2) entlang der Kanten der Hauptfläche angeordnet sind, wobei die erste Erdungselektrode (GND1) innerhalb der Anschlüsse (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vby1-2)auf der Hauptfläche liegt,

die Leistungsversorgungsanschlüsse (Vcc, Vab, VccL) der Verstärkerschaltungen (PA1-2, LNA1-2) und die Leistungsversorgungsanschlüsse (Vtxl-2, Vrx1-2) der Umschaltschaltungen (SPDT1-2, BypSW1-2) auf zwei entgegengesetzten Seiten der Hauptfläche angeordnet sind, und

die Eingabe- und Ausgabeanschlüsse (Tx, Rx) und der Antennenanschluss (Ant1-2) auf den anderen zwei entgegengesetzten Seiten der Hauptfläche angeordnet sind.

3. Hochfrequenzvorrichtung nach Anspruch 1 oder 2, wobei wenigstens ein Teil der Leistungsversorgungsanschlüsse (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrxl-2, VbL1-2, Vby1-2) die zweite Erdungselektrode (GND2) in einer Schichtungsrichtung überlappt.

4. Hochfrequenzvorrichtung nach einem der Ansprüche 1-3, wobei die anderen Enden der Leistungsversorgungsleitungen (lvab, lvccL, lvtx1-2, lvrx1-2) an die Hochfrequenzsignalbehandlungsschaltungen (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) über Durchgangselektroden angeschlossen sind, die in einer Region gebildet sind, die die erste Erdungselektrode (GND1) in einer Schichtungsrichtung überlappt.

5. Hochfrequenzvorrichtung nach einem der Ansprüche 1-4, wobei wenigstens ein Teil der Leistungsversorgungsanschlüsse (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrxl-2, VbL1-2, Vby1-2) nebeneinander liegt.

6. Hochfrequenzvorrichtung nach einem der Ansprüche 1-5, wobei Signalleitungen, die an die Eingabe- und Ausgabeanschlüsse (Tx, Rx) von Hochfrequenzsignalen angeschlossen sind, nicht auf der Leistungsversorgungsleitungslage (DL1) gebildet sind.

7. Hochfrequenzvorrichtung nach Anspruch 1, wobei wenigstens eine an die Eingabe- und Ausgabeanschlüsse (Tx, Rx) von Hochfrequenzsignalen angeschlossene Signalleitung in einer Region gebildet ist, die die erste Erdungselektrode (GND1) auf der Leistungsversorgungsleitungslage (DL1) in einer Schichtungsrichtung nicht überlappt.

8. Hochfrequenzvorrichtung nach einem der Ansprüche 1-7, wobei einige der Leistungsversorgungsleitungen (lvrx1, lvtx1) aufgebaut sind durch einen ersten Leitungsabschnitt, der auf der entgegengesetzten Seite der Leistungsversorgungsleitungslage (DL1) bezüglich der zweiten Erdungselektrode (GND2) gebildet ist, und zweite Leitungsabschnitte, die auf der Leistungsversorgungsleitungslage (DL1) gebildet und über Durchgangselektroden an beide Enden des ersten Leitungsabschnitts angeschlossen sind, wobei der erste Leitungsabschnitt, wenn in einer Schichtungsrichtung von oben gesehen, die anderen Leistungsversorgungsleitungen auf der Leistungsversorgungsleitungslage (DL1) kreuzt.

9. Hochfrequenzvorrichtung nach einem der Ansprüche 1-8, mit einem für mehrere Verstärkerschaltungen (PA1-2, LNA1-2) gemeinsamen Leistungsversorgungsanschluss (Vcc, VccL).

10. Hochfrequenzvorrichtung nach einem der Ansprüche 1-9, mit einer Niedrigrausch-Verstärkerschaltung (LNA1-2) als der Verstärkerschaltung, wobei ein Leistungsversorgungsanschluss (VbLl-2) gemeinsam für die Umschaltschaltungen (BypSW1-2) und die Niedrigrausch-Verstärkerschaltung (LNA1-2) verwendet wird.

11. Hochfrequenzvorrichtung nach einem der Ansprüche 1-10, wobei mehrere der Leistungsversorgungsleitungen (lvab, lvtx1-2, lvrx1-2) sich in mindestens zwei dreieckförmigen Regionen erstrecken, die durch diagonale Viertelung der dielektrischen Schicht mit der Leistungsversorgungsleitungslage (DL1) erhalten werden.

12. Hochfrequenzvornchtung nach einem der Ansprüche 1-11, wobei die Eingabe- und Ausgabeanschlüsse (Tx, Rx) von Hochfrequenzsignalen und die Leistungsversorgungsanschlüsse (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrxl-2, VbL1-2, Vby1-2) über andere Anschlüsse angeordnet sind.

13. Hochfrequenzvorrichtung nach einem der Ansprüche 1-12, wobei die Verstärkerschaltung (PA1-2, LNA1-2) aufweist:

    eine HochfrequenzVerstärkerschaltung (PA1-2) zum Verstärken von in den Eingabeanschluss (Tx) eingegebenen Sendesignalen, und/oder
    eine Niedrigrausch-Verstärkerschaltung (LNA1-2) zum Verstärken von durch den Antennenanschluss (Ant1-2) eingegebenen Empfangssignalen.

14. Hochfrequenzvorrichtung nach einem der Ansprüche 1-13, wobei einige der Leistungsversorgungsleitungen (lvab, lvccL, lvtx1-2, lvrx1-2) mindestens halb so lang wie eine Seite der Rückfläche des Schichtsubstrats sind.

15. Kommunikationsgerät mit der Hochfrequenzvorrichtung gemäß einem der Ansprüche 1-14.

Revendications

1. Dispositif à haute fréquence ayant des circuits de traitement de signal à haute fréquence (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) dans et sur un substrat stratifié comportant des pluralités de couches diélectriques (DL1-3) ayant des réseaux de conducteurs,
   lesdits circuits de traitement de signal à haute fréquence (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) ayant des circuits d'amplification (PA1-2, LNA1-2) et des circuits de commutation (SPDT1-2, BypSW1-2),
   des bornes (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vbyl-2) incluant des bornes d'entrée et de sortie (Tx, Rx) de signaux à haute fréquence,
   des bornes d'alimentation (Vcc, Vab, VccL) desdits circuits d'amplification (PA1-2, LNA1-2) et des bornes d'alimentation (Vtx1-2, Vrx1-2, VbL1-2, Vbyl-2) desdits circuits de commutation (SPDT1-2, BypSW1-2) étant formées sur une surface principale dudit substrat stratifié,
   des lignes d'alimentation (lvab, lvccL) ayant chacune une extrémité reliée à chacune des bornes d'alimentation (Vcc, Vab, VccL) desdits circuits d'amplification (PA1-2, LNA1-2) et des lignes d'alimentation (lvtxl-2, lvrx1-2) ayant chacune une extrémité reliée aux bornes d'alimentation (Vtx1-2, Vrx1-2) desdits circuits de commutation (SPDT1-2, BypSW1-2) étant formées sur une couche diélectrique pour constituer une couche de lignes d'alimentation (DL1),
   une première électrode de masse (GND1) étant agencée sur ladite surface principale par rapport à ladite couche de lignes d'alimentation (DL1), ladite première électrode de masse (GND1) recouvrant au moins une partie desdites lignes d'alimentation (lvab, lvccL, lvtx1-2, lvrx1-2) dans une direction de stratification,
   une seconde électrode de masse (GND2) étant agencée sur le côté opposé de ladite première électrode de masse (GND1) par rapport à ladite couche de lignes d'alimentation (DL1), ladite seconde électrode de masse (GND2) recouvrant au moins une partie desdites lignes d'alimentation (lvab, lvccL, lvtx1-2, lvrx1-2) dans une direction de stratification, ladite couche de lignes d'alimentation (DL1) étant prise en sandwich par ladite première électrode de masse (GND1) et ladite seconde électrode de masse (GND2) sans intercaler aucune autre électrode de

masse,
des électrodes de traversée reliées auxdites première et seconde électrodes de masse (GND1, GND2) étant agencées entre lesdites lignes d'alimentation (lvab, lvccL) desdits circuits d'amplification (PA1-2, LNA1-2) et lesdites lignes d'alimentation (lvtx1-2, lvrx1-2) desdits circuits de commutation (SPDT1-2, BypSW1-2), et
lesdits circuits de traitement de signal à haute fréquence (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) étant agencés sur le côté opposé de ladite couche de lignes d'alimentation (DL1) par rapport à ladite seconde électrode de masse (GND2).

2. Dispositif à haute fréquence selon la revendication 1, dans lequel
ladite couche diélectrique (DL1) est rectangulaire,
ledit circuit de commutation (SPDT1-2, BypSW1-2) est adapté pour commuter la connexion d'une borne d'antenne (Ant1-2) vers les bornes d'entrée et de sortie (Tx, Rx) desdits signaux à haute fréquence,
lesdites bornes (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrxl-2, VbL1-2, Vbyl-2) sont agencées le long des bords de ladite surface principale, avec ladite première électrode de masse (GND1) à l'intérieur desdites bornes (Tx, Rx, Vcc, Vab, Vpd, VccL, Vtx1-2, Vrxl-2, VbLl-2, Vbyl-2) sur ladite surface principale,
lesdites bornes d'alimentation (Vcc, Vab, VccL) desdits circuit d'amplification (PA1-2, LNA1-2) et lesdites bornes d'alimentation (Vtx1-2, Vrx1-2) desdits circuits de commutation (SPDT1-2, BypSW1-2) sont agencées sur deux côtés opposés de ladite surface principale, et
lesdites bornes d'entrée et de sortie (Tx, Rx) et ladite borne d'antenne (Ant1-2) sont agencées sur les deux autres côtés opposés de ladite surface principale.

3. Dispositif à haute fréquence selon la revendication 1 ou 2, dans lequel au moins une partie desdites bornes d'alimentation (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vbyl-2) recouvre ladite seconde électrode de masse (GND2) dans une direction de stratification.

4. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 3, dans lequel lesdites autres extrémités des lignes d'alimentation (lvab, lvccl, lvtx1-2, lvrx1-2) sont reliées auxdits circuits de traitement de signal à haute fréquence (SPDT1-2, BypSW1-2, PA1-2, LNA1-2) par des électrodes de traversée formées dans une région recouvrant ladite première électrode de masse (GND1) dans une direction de stratification.

5. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 4, dans lequel les bornes d'au moins une partie des bornes d'alimentation (Vcc, Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vbyl-2) sont adjacentes les unes aux autres.

6. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 5, dans lequel des lignes de signal reliées auxdites bornes d'entrée et de sortie (Tx, Rx) des signaux à haute fréquence ne sont pas formées sur ladite couche de lignes d'alimentation (DL1).

7. Dispositif à haute fréquence selon la revendication 1, dans lequel au moins une ligne de signal reliée auxdites bornes d'entrée et de sortie (Tx, Rx) de signaux à haute fréquence est formée dans une région ne recouvrant pas ladite première électrode de masse (GND1) sur ladite couche de lignes d'alimentation (DL1) dans une direction de stratification.

8. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 7, dans lequel certaines desdites lignes d'alimentation (lvrx1, lvtx1) sont constituées d'une première portion de ligne formée sur le côté opposé de ladite couche de lignes d'alimentation (DL1) par rapport à ladite seconde électrode de masse (GND2), et des secondes portions de ligne formées sur ladite couche de lignes d'alimentation (DL1) et reliées aux deux extrémités de ladite première portion de lignes via des électrodes de traversée, ladite première portion de ligne croisant les autres lignes d'alimentation sur ladite couche de lignes d'alimentation (DL1) lorsque vues du dessus dans une direction de stratification.

9. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 8, comportant une borne d'alimentation (Vcc, VccL) commune à des pluralités de circuits d'amplification (PA1-2, LNA1-2).

10. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 9, comportant un circuit d'amplification à faible bruit (LNA1-2) en tant que dit circuit d'amplification, une borne d'alimentation (VbL1-2) étant utilisée en commun pour lesdits circuits de commutation (BypSW1-2) et ledit circuit d'amplification à faible bruit (LNA1-2).

11. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 10, dans lequel des pluralités de lignes d'alimentation (lvab, lvtx1-2, lvrx1-2) s'étendent dans deux ou plus de deux régions triangulaires obtenues en divisant diagonalement en quatre la couche diélectrique ayant ladite couche de lignes d'alimentation (DL1).

12. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 11, dans lequel lesdites bornes d'entrée et de sortie (Tx, Rx) de signaux à haute fréquence et lesdites borne d'alimentation (Vcc,

Vab, Vpd, VccL, Vtx1-2, Vrx1-2, VbL1-2, Vbyl-2) sont agencées via d'autres bornes.

13. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 12, dans lequel ledit circuit d'amplification (PA1-2, LNA1-2) comporte :

un circuit d'amplification à haute fréquence (PA1-2) pour amplifier des signaux d'émission appliqués à l'entrée de ladite borne d'entrée (Tx), et/ou
un circuit d'amplification à faible bruit (LNA1-2) pour amplifier des signaux reçus appliqués en entrée par l'intermédiaire de ladite borne d'antenne (Ant1-2).

14. Dispositif à haute fréquence selon l'une quelconque des revendications 1 à 13, dans lequel certaines desdites lignes d'alimentation (lvab, lvccL, lvtx1-2, lvrx1-2) sont aussi longues que la moitié ou plus d'un côté de la surface arrière dudit substrat stratifié.

15. Appareil de communication comportant le dispositif à haute fréquence selon l'une quelconque des revendications 1 à 14.

Fig. 1

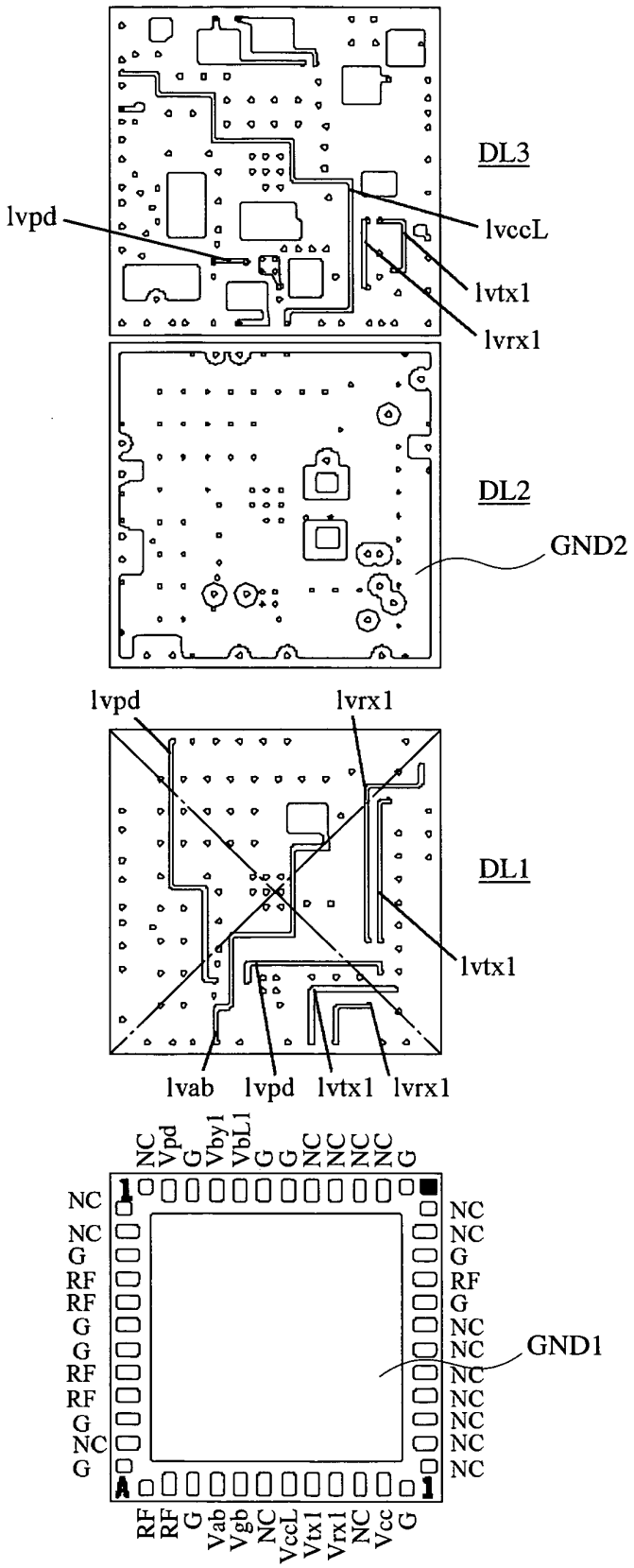

DL3
lvpd
lvccL
lvtx1
lvrx1
DL2
GND2
lvpd
lvrx1
DL1
lvtx1
lvab
lvpd
lvtx1
lvrx1
NC
Vpd
G
Vby1
VbL1
G
G
NC
NC
NC
NC
G
NC
NC
G
RF
RF
G
G
RF
RF
G
NC
G
NC
NC
G
RF
RF
G
NC
NC
G
NC
NC
NC
NC
NC
NC
NC
NC
NC
GND1
RF
RF
G
Vab
Vgb
NC
VccL
Vtx1
Vrx1
NC
Vcc
G

Fig. 2

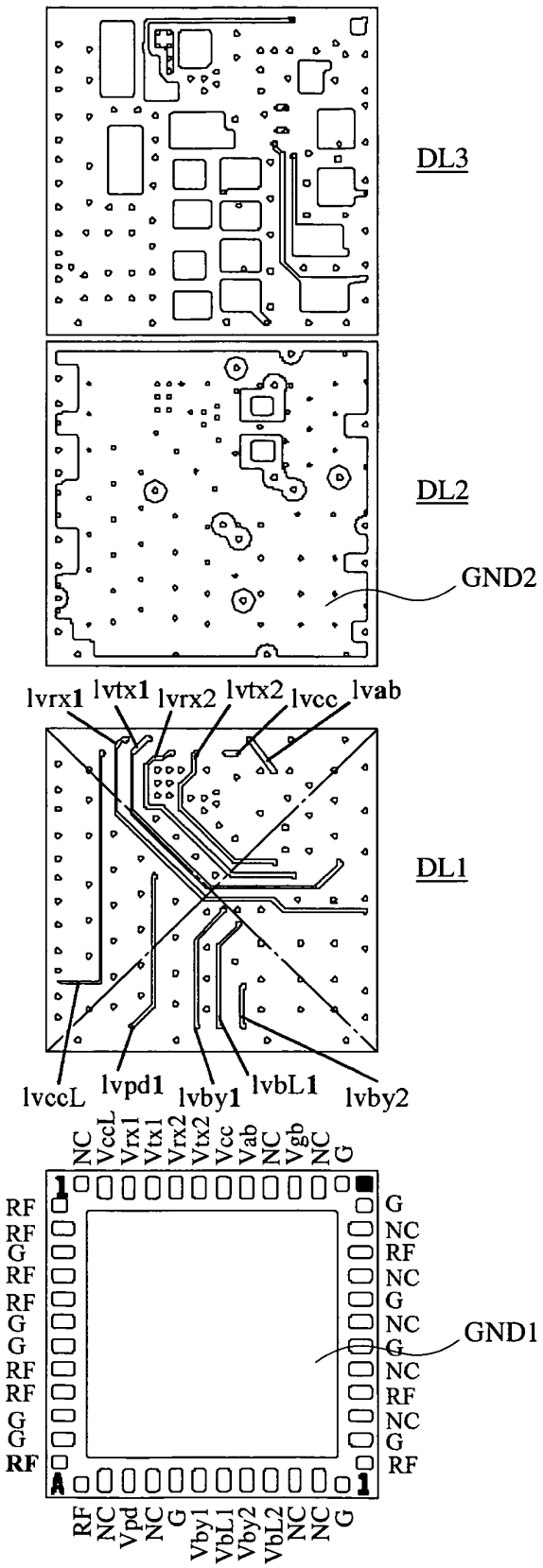

DL3
DL2
GND2
lvrx1
lvtx1
lvrx2
lvtx2
lvcc
lvab
DL1
lvccL
lvpd1
lvby1
lvbL1
lvby2
NC
VccL
Vrx1
Vtx1
Vrx2
Vtx2
Vcc
Vab
NC
Vgb
NC
G
1
RF
RF
G
RF
RF
G
G
RF
RF
G
G
RF
G
NC
RF
NC
G
NC
G
NC
RF
NC
G
RF
A
1
RF
NC
Vpd
NC
G
Vby1
VbL1
Vby2
VbL2
NC
NC
G
GND1

Fig. 3

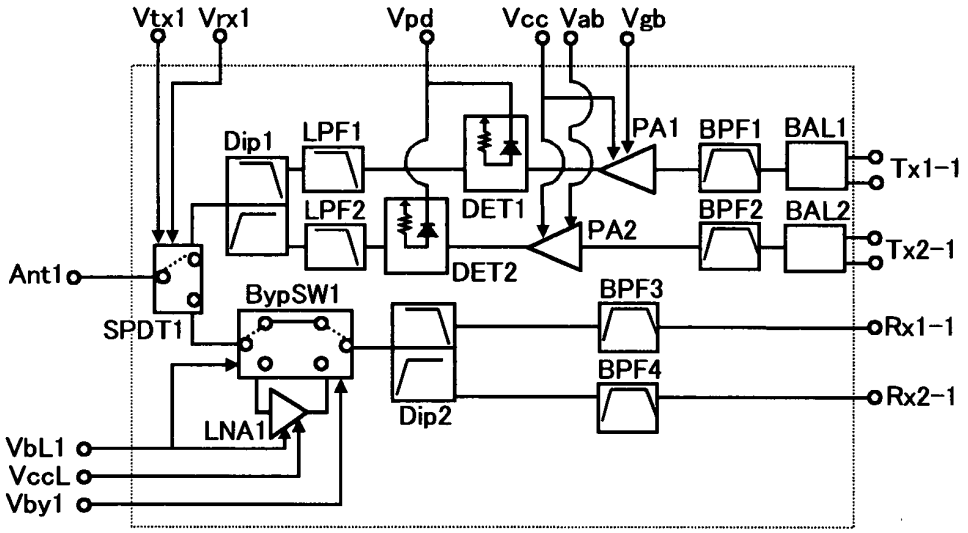

Vtx1
Vrx1
Vpd
Vcc
Vab
Vgb
Dip1
LPF1
LPF2
DET1
DET2
PA1
PA2
BPF1
BPF2
BAL1
BAL2
Tx1-1
Tx2-1
Ant1
SPDT1
BypSW1
BPF3
BPF4
Rx1-1
Rx2-1
Dip2
LNA1
VbL1
VccL
Vby1

Fig. 4

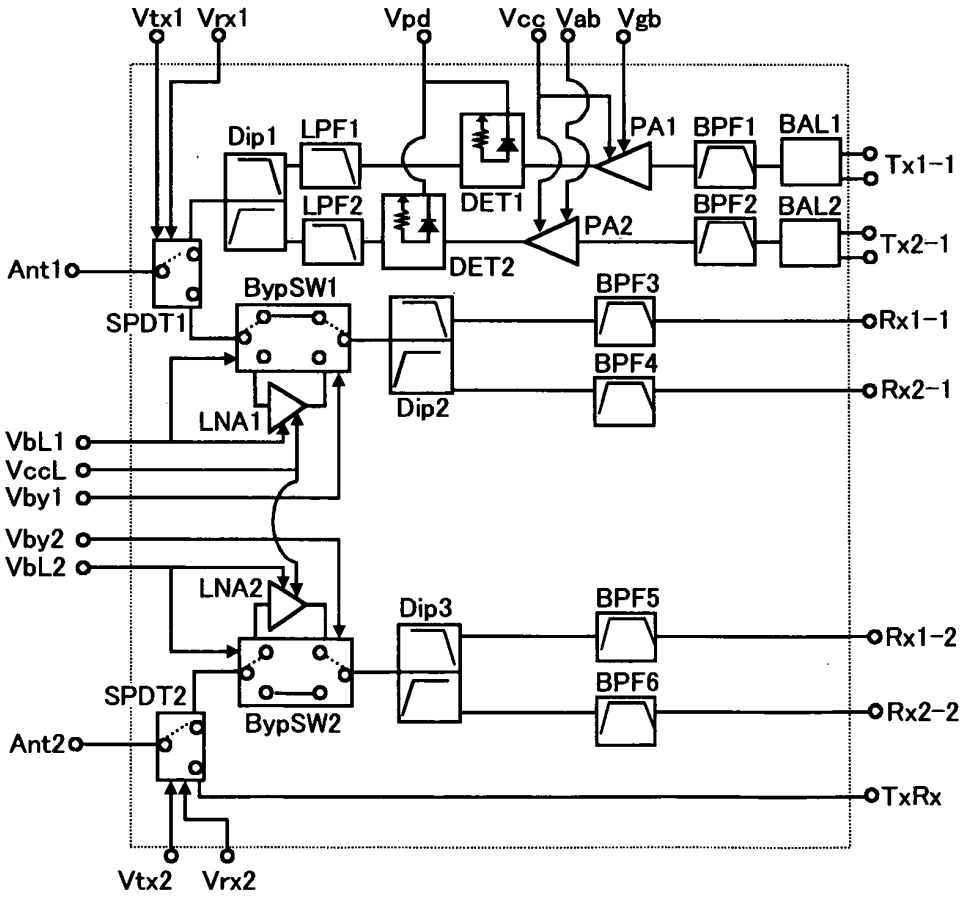
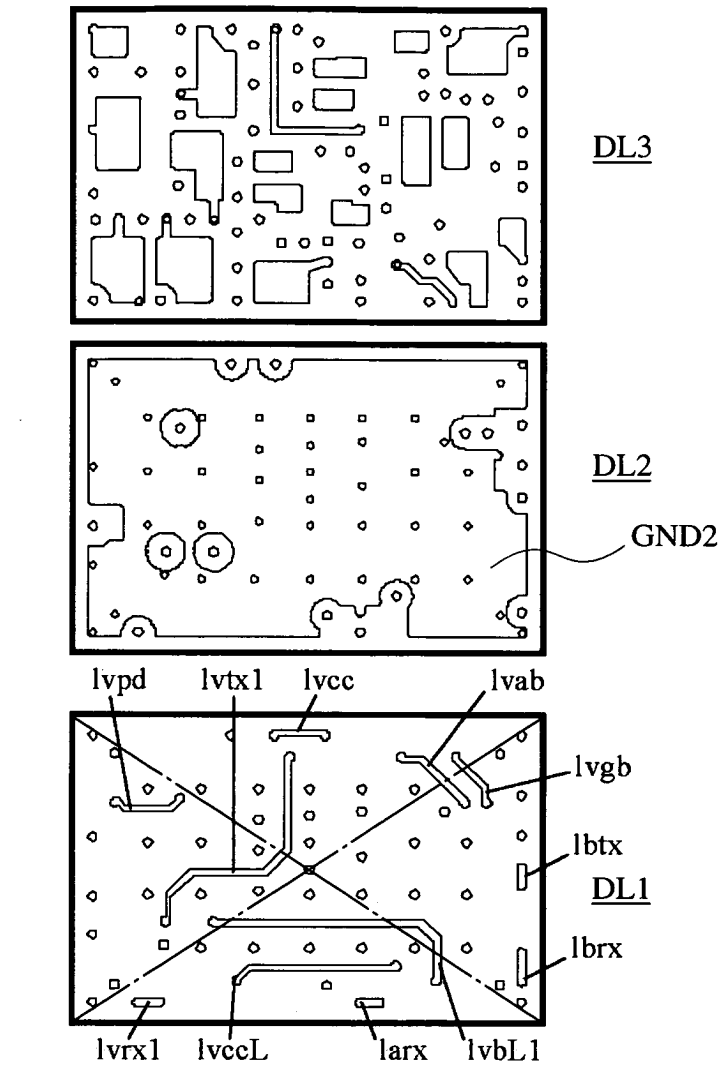

Vtx1
Vrx1
Vpd
Vcc
Vab
Vgb
Dip1
LPF1
LPF2
DET1
DET2
PA1
PA2
BPF1
BPF2
BAL1
BAL2
Tx1-1
Tx2-1
Ant1
SPDT1
BypSW1
BPF3
BPF4
Rx1-1
Rx2-1
Dip2
LNA1
VbL1
VccL
Vby1
Vby2
VbL2
LNA2
Dip3
BPF5
BPF6
Rx1-2
Rx2-2
SPDT2
BypSW2
Ant2
TxRx
Vtx2
Vrx2

Fig. 5


DL3
DL2
GND2
lvpd
lvtx1
lvcc
lvab
lvgb
lbtx
DL1
lbrx
lvrx1
lvccL
larx
lvbL1
G
VHi/Lo
VIDON
Vtx1
Vcc
Vab
Vgb
G
Vpd
G
RF
G
G
RF
RF
RF
RF
GND1
Vrx1
VccL
NC
RF
RF
VbL1
G

REFERENCES CITED IN THE DESCRIPTION

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